MASTER BOILER MAKERS' ASSOCIATION

COMMITTEE REPORTS

PREPARED FOR THE

THIRTEENTH ANNUAL CONVENTION

1921

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Master Boiler Makers Association

OFFICIAL REPORTS

PREPARED BY COMMITTEES

FOR THE

Thirteenth Annual Convention

CONTENTS

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Died July 23, 1920

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Died February 28, 1920

JOHN T. NEARY

Died March 12, 1921

Reports Prepared for Thirteenth Annual Convention

Financial stress and serious business conditions on the railroads having for obvious reasons made it desirable to cancel the convention which was to have been held at St. Louis on May 23 to 26, 1921, the Executive Committee has authorized this publication of the reports of committees on subjects prepared and filed for the occasion, in place of the Official Proceedings which would otherwise have been issued.

The object is to afford members ample opportunity to study the reports and be prepared to discuss them at the next convention.

Also to make any recommendations suggested to their minds that will be of assistance to the chairmen in the event that they deem it desirable to revise or amplify their reports for the 1922 convention.

Such recommendations should be sent in writing to the chairman of each committee whose address is shown with each report and will also be found in the revised list of members of the Association that is included in this book for the information of all concerned.

CHARLES P. PATRICK, President,
JOHN F. RAPS, Chairman, Executive Board,
HARRY D. VOUGHT, Secretary.

Report of Special Committee on Investigation of Autogenous Welding

THOMAS F. POWERS, System General Foreman, Chicago & Northwestern Railroad, 1129 South Clarence Avenue, Oak Park, Ill., Chairman.

JOHN F. RAPS — C. E. ELKINS
JOHN HARTHILL — H. J. WANDBERG
W. J. MURPHY

The purpose of this special committee was to investigate autogenous welding by personal observation owing to conflicting reports by different members on the floor of our conventions. At first, we were under the impression that we should join our investigation with the committee of the American Welding Society and the Standard Boiler Code Committee of the American Society of Mechanical Engineers. After due consideration, it was our conclusion that the object of the three committees was along different lines and your committee decided to ascertain, by actual investigation, the results obtained from autogenous welding.

Your committee has visited at least one shop on more than 25 railroads and as many as eight shops and roundhouses were visited on some of the railroads.

We found that autogenous welding for firebox repairs is used by every railroad visited and in most cases successfully. We do not believe that it is necessary to go into detail as to what is being done on the various roads by autogenous welding, other than to say that we found complete firebox with no rivets above the mud ring, patches collar patches around fire holes, corner patches, one-half and full side

sheets, one-half flue sheets and one-half door sheets, cracks, checks out of staybolt holes and crown sheets and combustion chamber sheets welded in.

We think it is sufficient to say your committee is satisfied from their investigation that, as a general proposition, autogenous welding of fireboxes is successful. We do not claim that there have been no failures in welding. We are satisfied that every railroad has had failures from autogenous welding, but our investigation has satisfied us that most of the railroads are improving their autogenous welding year by year; that welders are getting to understand the process better; that more care is used in the selection of welders; that foremen are very much alive to the fact that it is necessary to properly educate welders and that a welder, to be successful, must be educated to make welds that will stand up under service.

Your committee is satisfied that welds can be made, and are being made that will hold as well as the original sheet even when subject to the most severe strains and tests.

Unfortunately, other welds are being made that, while they hold for a time, when subjected to severe tests or even under the ordinary working conditions of a locomotive, have failed. However, we are satisfied from our investigation that poor welds in the locomotive fireboxes are getting fewer and fewer.

It is our opinion that inexperienced operators, poor welding material and improperly prepared work have been the principal causes of failures in autogenous welding. It is now a recognized fact that welders cannot be made within a few weeks. It takes months of experience before an operator becomes proficient enough to be trusted with autogenous welding in locomotive fireboxes, and it is our belief that if we are to avoid failures in autogenous welding, we must keep the inexperienced welder out of the fireboxes.

We quote below part of a letter written by Mr. H. H. Service, Supervisor of Welding Equipment on the Santa Fe Railroad, and we believe that if this practice is adopted, it will overcome some of the failures:

> "It is my opinion and belief that we should first prove that the welding in fireboxes is done efficiently and is stronger than the riveted seam. To illustrate to you the work which we are following on the Santa Fe, we are asking all our welders, both oxyacetylene and electric, to make a test field once each month and he is given his efficiency later after the test specimens have been tested. When his efficiency or tensile strength is below 70 per cent., his attention is called to this fact and he is asked to do better. Another feature we are watching closely is, that when the firebox is removed for a renewal, we endeavor to test all parts of the old welded seams wherever we can secure test specimens."

Another cause of failures in autogenous welding, is work improperly prepared. From our observations and discussions with various boiler foremen, we have agreed that it is necessary that work be properly prepared; that openings be neither too large nor too small, and above all that they be kept free from dirt. To secure good welding, firebox sheets must be clean. It is a mistake to use one grade of welding iron for all purposes. Jobs have been done with fence wire, nails, scrap metal from sheet shearing and what not, and it is no wonder that so many varieties of success and failures are found. When firebox material is specified for a firebox, tank steel should not be used and if it is necessary to make up firebox steel to certain specifications, it is also necessary that any of the material used in the


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repairs that go into this firebox should be just as good as the original firebox material, and it is our opinion that all welding wire should be made to specifications.

The idea of doing anything or everything by autogenous welding with any kind of an operator, or any kind of welding material, or without the proper kind of supervision, is entirely wrong. Autogenous welding is not a divine healer. Unless good judgment is used in its application and as long as loose attention is given to its use, there will be conflicting opinions as to its success.

It appears that there is considerable difference of opinion relative to the success or failure of welding flues to the back flue sheet. Many roads feel that they can get greater mileage by welding their flues, while other roads are not so successful. The success of welding of flues, whether done at the time of application or after the locomotive has been in service for some time, in our opinion, depends on several conditions which must be taken into account. Some of these are: feed water conditions, the kind of coal used, use of injector, whether the firebox is with or without combustion chamber and whether or not water is treated. Some railroads claim to have increased their mileage as high as 50% with welded flues with a big reduction in engine failures from flues leaking; while other roads, especially in bad water districts, are unable to get as much mileage from welded flues as when they are not welded, and have a great deal of trouble with cracked bridges in the back flue sheets. It is sufficient to say that the welding of flues is something that will have to be worked out according to local conditions. We are satisfied that there are roads which are running flues welded to the back flue sheet successfully. We are also satisfied that there are other railroads, due to water and other conditions, which are unable to run welded flues successfully.

In conclusion, it might be well to state that your committee has personally inspected welding under various conditions, both in the roundhouses and shops, and we are satisfied that autogenous welding in all its varieties is a success. Were it not so, it would soon be discouraged and discontinued. The fact that it is being used and its use extended by most of the railroads in this country, is evidence that it is a good form of repair. It is economical and quick, and is as essential in the shops and roundhouses today as air and pneumatic tools. As stated above, there have been and will be failures just as there is good and bad riveting, caulking, etc., and we are of the opinion that each railroad or section of railroad will work out its own method of repairs based upon conditions and experience.

Report of Committee on Topic No. 1

DESCRIBE PRESENT AND BEST METHOD OF WELDING SAFE ENDS ON LOCOMOTIVE TUBES: IRON END TO IRON BODY; STEEL END TO IRON BODY; STEEL END TO STEEL BODY; SHAPE AND LENGTH OF SCARF AND FLUX IF USED; RESULTS OBTAINED BY APPLYING SAFE ENDS WITHOUT SCARFING; DEGREE OF HEAT NECESSARY TO OBTAIN BEST RESULTS IN WELDING, AND ADVISABILITY OF HAVING A PYROMETER ON WELDING FURNACE

P. J. CONRATH, Boiler Tube Expert, National Tube Co., 4414 Michigan Avenue, Chicago, Chairman.

J. A. DOARNBERGER ALFRED P. STIGLMEIER

In submitting report on the above subject, and as Chairman of this committee, in making composite report, I have therein embodied the substance of individual reports by the other committeemen, as well

as information gathered by the Chairman during the year in visiting the large railroad shops throughout the country and his past personal experiences.

We will first take up the welding of safe ends in the regular way which is in vogue in most of the large railroad shops, viz: the oil furnace, roller and hammer welders. It seems to be the consensus of opinion of the committee that no difficulty is experienced in welding iron to iron, steel to steel, iron to steel, or vice versa. In this connection I wish to say, however, that where steel is being welded to iron, it is good practice to give the iron somewhat of a lead in the heat, as steel will weld very readily up from 2500° to 2600° F., and iron fuses nicely at about 2800° to 3000°. This can be very readily done when heating the tube and opening it to receive the safe end; then return to furnace immediately and it will have about the required lead in heat over the steel. If the tube should be placed in the fire with both iron and steel cold, I believe it to be good practice to set the material in the furnace so as to give the iron the benefit of the heat. With this practice there should be no trouble in welding steel to iron, or vice versa.

The committee seems to be somewhat divided on the scarfing of safe ends. A large number of shops are welding safe ends onto tubes without scarfing, with very good results. The committee, however, recommends that the sharp burr be taken off the outer edge of the safe end before inserting it into tube; otherwise when being rolled down in welding the sharp edge cuts in and thereby weakens the wall of the tube, causing the tube in some cases to break off. It is my opinion that the scarfed safe end makes the smoother weld, providing the scarf is properly made; about ½ inch in length and at the thinnest end to be not less than $\frac{1}{16}$ inch thick, instead of scarfing them down, as we find in a good many cases, to a feather edge. It is the further opinion of the committee that it is not necessary to use flux in welding, the reason being that in a good many cases dirt and foreign matter become mixed with the flux, and when it is applied to the metal prevents cohesion, and the result is a defective weld. If the flux can be kept perfectly clean there seems to be no objection in the use of it. A very fine sand is being used in some places and, it is claimed, with very good results. If, however, the welding qualities of the material are right, and the furnace constructed so that it will properly heat the material, there should be no trouble in welding without the flux.

Investigating complaints of trouble experienced in the welding of safe ends, we find that this can be attributed mostly to one or two things, or both—improper construction of the furnace and the roller welding machine not being speeded up to the revolutions necessary to make a quick and sound weld. The roller welding machine should have a speed of not less than 450 revolutions at the fly wheel. The material being of a very light wall, it cools very rapidly, and therefore must have quick action for fusing. In our opinion, some of the trouble complained of is due to the oil burners being set so that they play directly upon the material to be heated; especially is this a fact in short furnaces. Where the oil is of a very good grade and light there seems to be no trouble in properly heating the material, but when the oil is dirty and of a heavy grade proper combustion will not take place in the short distance. The results are that where specks of this oil strike the metal along the line of the weld the material will not amalgamate; the result is a defective weld. The burner should be placed so that it will not blow directly upon the material; better at right angles, either top or bottom. In some cases I have found that


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they mixed heavy crude with kerosene oil; this brought about better combustion and better results were obtained from the furnace. The heavy oil clogging the burner, causes the temperature to fluctuate, and the material is wasted in the furnace without being given the proper degree of heat for welding. The temperature of the furnace should be kept above the welding heat; if possible, 300° to 400°, and it is the opinion of the committee that it is necessary to use a pyrometer only in cases where the desire is to establish the proper heat for welding. This, however, is not necessary with an experienced flue welder, as his eye will readily detect the proper degree of heat for welding, and the pyrometer should only be used as a matter of education.

Welding safe ends by the electrical spot welding machine, in the opinion of the committee, will eventually supersede the present method. Mr. John Doarnberger, a member of this committee, for the benefit of the Association, has made a number of tests, both as to cost, quality of material, and strength of welds. He states that the average consumption of current is about 20,000 watts, or in other words, 20 kilowatts. In considering the cost the current is one cent per kilowatt hour delivered to the machine, and would cost about 20 cents per hour for current. Mr. Doarnberger claims that he can turn out about 85 flues per hour, which would make the cost per flue about ¼ cent for current. To operate this machine, however, it is necessary to have available alternating current, 60 cycle, with 110 or 120 volts. They will not operate on direct current. These machines will operate very satisfactorily, however, over a wide range of voltage. The present machine at the Roanoke, Virginia, shop, Mr. Doarnberger states, has a minimum of 170 and a maximum voltage of 300, and under these conditions it is commercially possible to put them on any lighting or power circuit that may be available, providing the current is generated in a standard apparatus, or purchased from any ordinary lighting company operating under conditions as found in the average town. When tubes are welded by the electrical spot welder it is not necessary, according to reports and information gathered, to test them before applying to the boiler, as there is less than one per cent. of leakage found in tubes welded this way when under the hydrostatic test. The Norfolk & Western Railroad now has in service approximately 280,960 tubes welded by this method, 152,000 being welded in 1919, and no failures are reported. The Union Pacific Railroad is welding about 60 tubes per hour. It claims to have over 700,000 in service, and only two service failures out of this number, those that failed being in service more than three years.

In connection with the electrical spot welder, I find tubes and safe ends being chamfered to about 30° at the Omaha shop and when the safe end is inserted there is a lap of about $\frac{3}{16}$ inch, and this, in my opinion, is the better method; or, I would prefer it over the butt-welded, because if the material carbonized and broke off at the weld, after going into service, it would drop into the boiler. On the other hand, if it is lapped there is less liability of the tube breaking off from the safe end completely, and in this way would cause less damage.

At the Atchison, Topeka & Santa Fe shops I found the most up-to-date electrical spot welding machine, which has a roller attachment on the machine, the tube being heated and rolled down without moving from the machine to the roller, as is the practice in other shops where the spot welder has no roller attachment. These people, however, are using the machine mostly for reclaiming, welding from six inch to 10 inch and about 35 or 40 tubes per hour. Of course, you will readily understand that the handling of the longer pieces takes up the time.

Following is the strength of new 2¼ inch tubes without a weld:

37,820 lbs.	Average 37,921⅔ lbs.
37,770 lbs.	
38,030 lbs.	
38,030 lbs.	
38,030 lbs.	
37,800 lbs.	

COKE WELDED

31,130 lbs.	Average 33,236⅔ lbs. Efficiency 87⅔%.
36,380 lbs.	
28,370 lbs.	
37,060 lbs.	
32,550 lbs.	
33,930 lbs.	

ELECTRICALLY BUTTWELDED

31,290 lbs.	Average 34,020 lbs. Efficiency 90.6%.
37,240 lbs.	
33,020 lbs.	
38,770 lbs.	
33,450 lbs.	
30,350 lbs.	

The chairman of the committee has also conducted a test with 12 electrically spot welded two inch tubes which proved to have an efficiency of over 90% of the strength of the metal.

In conclusion, I wish to say that in most large shops—with the present method of furnace, roller and hammer welding—two men are employed in the welding, one piecing up and the other welding. In this way the tube is not allowed to cool off and it takes less time to heat; you might say brings about continuous welding. I find that in most up-to-date shops they claim to weld about 50 tubes per hour, some places, however, are doing even better than that.

Report of Committee on Topic No. 3

WHICH IS THE BETTER CROWN STAY FOR THE DIFFERENT CLASSES OF LOCOMOTIVES; THE STAY SCREWED INTO THE CROWN SHEET WITH THE TAPER AND RIVETED OVER; OR THE BUTTON HEAD CROWN STAY?

LEWIS NICHOLAS, JR., General Boiler Inspector, C. I. & L. Railway, Lafayette, Ind., Chairman.

T. F. POWERS J. J. MANSFIELD

Up to several years ago, the crown stay generally used on the radial stay fireboxes was of the button head type. The more general use of oil as fuel in fireboxes demonstrated the need of a crown stay without as much bulk and of a smaller head than the button head type. This was due to the large amount of iron used in the head of the button type of bolt becoming over-heated and crumbling away, due to the extreme temperature of the fire in an oil burning firebox.

In most cases when the button head bolt was used in oil burning fireboxes, they could not be maintained. The heads on the bolts crumbled and broke away in pieces, leaving the crown bolt in weakened condition.

The riveted head bolt with a taper was then generally adopted on most oil burning fireboxes and was generally a success. Due to the success of the hammered head bolt in oil burners and the fact that

it was much easier to apply and maintain, it was then adopted on some roads as a standard for coal burning locomotives as well as those burning oil.

The only objection that can be raised against the use of the hammered head bolt with taper, used as crown stay, is the fact that it is not as strong as the button head bolt. Answering this objection, it may be said, that in the first place, it will have to be admitted that the hammered head bolt with a taper is of ample strength under ordinary working conditions; that is, with water over the crown sheet, as it will stand from 18,000 to 20,000 pounds before pulling through the crown sheet and under ordinary conditions, all the bolt is called upon to stand with 200 pounds pressure with a spacing of 4 x 4 inches is 3,200 pounds. The only time the strength of the bolt can be questioned is when the sheet becomes overheated, and it is well known that the button head type of bolt will not hold up the crown sheet when it becomes overheated. Then the only question to be considered, is how much longer will the button head type of bolt hold than the hammered head bolt with a taper when the crown sheet is overheated, bearing in mind that it is questionable whether we want the sheet to hold until the plates are badly overheated and soft, or prefer to have them let go as soon as possible after the water gets below the high point of the crown sheet?

This should bring out some debate in the discussion of this paper, as we have all seen some very bad explosions with both types of bolts.

In order to reduce the amount of iron in the fire, some roads made it a practice on all oil burning locomotives, to drill off one-third to one-half the head on the button head radials when they were used in the crown sheet. This was not a success as it still left a large amount of iron and like the full button head bolt, crumbled and left the bolt in a weakened condition. Before adopting the hammered head radial with a taper, the road with which the chairman of this committee is connected, made some tests which in part are as follows:

Test No.	Condition of Pull	Where Broken	Kind of Head	No. Lbs.	Remarks
1	Cold	Head pulled off	Button head with 1/3 head drilled off	23750	Plate dished 1/4
15	Cold	Bolt broke 3 ft. from head	Full button head	29510	Plate dished 1/8
4	Cold	Head pulled through sheet	Hammered head with taper 1½" in 12"	19400	Plate dished 5/16
14	Cherry red	Head pulled off	Full button head	7100	Plate dished 3/16
7	Cherry red	Head pulled off	Button head with 1/3 head drilled off	7730	Plate dished 5/16
11	Cherry red	Head pulled through sheet	Hammered head with taper 1½" in 12"	2900	Plate dished 5/16

All of the above tests, with the exception of those made cold, were made with the heat as near the same temperature as it was possible to get them, that is, about a cherry red. It can be seen that as long as the sheet is cold the hammered head type of bolt is of ample

strength and even when the sheet is cherry red, it takes 2,900 pounds to force the plate from the bolt. If, as in most cases, it has been found necessary to adopt the hammered head bolt with a taper on oil burning locomotives, (and from all we are able to learn, these are the only bolts which can successfully be maintained in an oil burner.) We believe that the whole thing can be summed up in the phrase, "that what is sauce for the goose is sauce for the gander," and that this type of bolt if used in an oil burning locomotive should certainly be a good thing in a coal burner.

We would recommend for the following reasons the adoption of the stay screwed into the crown sheet with the taper and riveted over.

1. That it is of ample strength.
2. It is easier to apply than the button head on account of being tapered.
3. Less work is needed to replace on account of the rank taper in firebox; can be cut free in roof sheet and in firebox, and driven clear of crown sheet, thereby avoiding a lot of extra work cleaning broken ends off of crown sheet, where, in a great many cases, bodies of bolts become fast between braces and cannot be removed.
4. Easier to get tight and does not strip, can be pulled up tight regardless of the angle of the sheet.
5. Gives little or no trouble in service, while the button head type of bolt leaks very easily, and when it does leak it is hard to caulk, and if not caulked properly is wedged away from the sheet, making it necessary to renew the bolt.
6. Gives a cleaner crown sheet both on the water and fire sides of the sheet, and does not collect dirt and cinders as does the button head, and gives a more even head surface.
7. Can be manufactured at less cost than the button head stay.
8. Gives a saving in tool bills, both in making of bolts and in reaming and tapping, as the one tap and reamer can be made to do for three or four diameters.
9. Can be carried in stock threaded at both ends ready for use.

In applying the hammered head radial with taper, we would suggest that the first five rows of radials in the center of the crown sheet from the back flue sheet be applied without the taper. This weakens the high point of the crown sheet and in case of low water, probably would let go by bagging and pulling out these few bolts while the rest of the crown sheet with the taper radial stay would hold.

Report of Committee on Topic No. 4

HOW CAN THE DETERIORATION OF FIREBOXES BEHIND GRATE BARS BE ELIMINATED?

C. E. Elkins, General Foreman Boilermaker, Missouri Pacific Railroad, 1212 West 11th St., Little Rock, Ark., Chairman.

John J. Orr C. F. Petzinger

The most active agent of corrosion behind grate bars is sulphurous acid gas produced from the sulphur in the coal which is converted into sulphuric acid in the presence of moisture in the cold.

The principal reasons for this condition are poorly constructed grate bars and supports and ash pan hanger sheets, together with leaky mud ring rivets and staybolts, side bars and supports being so constructed that they hold the coal and cinders against the side sheet

and the moisture from the leaky staybolts or rivets soon causes the sheet to deteriorate.

To prevent this condition, the grate bars should be constructed to fit up tight against the side sheet on top and should also have the top of bar made at an angle of 45° instead of flat on top. This will have a tendency to keep the coal from going down behind the bars. There should also be all the opening possible between the sheet and bars at bottom to allow any coal or cinders that might work down from firebox to fall on through.

If this practice is carried out and the mud ring rivets and the staybolts are tight, no great amount of trouble will be experienced from deteriorated side sheets. It is also a good plan when the grate bars are removed to have the side sheets thoroughly cleaned and painted with a heavy coat of rust proof paint.

Report of Committee on Topic No. 5

WHAT IS THE CAUSE OF BOILER SHELL CRACKING THROUGH GIRTH SEAM RIVET HOLES? IS THERE ANY WAY IN WHICH THIS CAN BE OVERCOME OR THE TIME OF RUPTURE PROLONGED?

ANDREW S. GREENE, General Foreman Boilermaker, Big Four System, 3209 East 16th St., Indianapolis, Ind. Chairman.

WILLIAM A. MCKEOWN T. W. LOWE

Your committee respectfully submits the following for your consideration:

One member of the committee after 45 or 50 years experience can only recall 10 boilers which failed when the boiler shell cracked circumferentially. Five were locomotive boilers which cracked through the rivet holes at the external lap, two cracked through the rivet holes at internal lap, and one through the main plate at the abutment of the lap. Two returned tubular boilers cracked through the rivet holes of the external lap. These boilers all developed cracks ranging in length from three to four feet, extending about equal distances to each side of bottom center line.

The locomotive boilers had double riveted girth seams and the tubular boilers single riveted girth seams. The girth seams in all boilers which cracked did not become defective because of a low factor of safety as they had factors in excess of that prescribed by both the governments of the United States and Canada. Not one of these cracks resulted in the explosion of the boiler.

The other two members of the committee, after making inquiries and observations from numerous railroads, find very few boiler shells cracking through the girth seam rivet holes and what has come to their attention was due to carelessness in preparing the sheets for riveting.

It must be quite clear to all of us that the plates in the steam space on the locomotive boiler must expand to a greater extent than the water space of the shell of the boiler, and the difference in the expansion between the top and bottom of shell in the locomotive type of boiler is dependent on the temperature of the steam at the top and the water below.

At first it would be thought that the top of the boiler would fail in advance of the bottom, but this is not so, because expansion

is occurring equally and normally over every unit of its length, whereas the lower shell is subjected to a higher tension of stress brought about by the expansion of the top, which stress the bottom cannot equal because of its low temperature. This in our opinion, causes the cracking of the shellplate through the girth seam rivet hole and the shell of the boiler, usually starting at the bottom.

It is our opinion that the rivet hole should be drilled in the girth seam and sheets properly prepared for riveting, and other improvements, which would quicken circulation such as applications of feed water with top checks located at the top of the boiler and at a distance from the fire; feed water heaters to raise the temperature of the feed water; automatic feed water regulation with regulators which would supply and keep the water as near as possible at a normal working level under all conditions. Also keep the expansion pads that secure the boiler to the frame free. Allowing the boiler to breathe and move freely in the frame will often prolong the rupture.

In our opinion with such improvements in general use on boilers the differential between the expansion of top and bottom of the shell would become more normal, with a reduction in the number of failures and the cracking of rivet holes in the girth seam, and the time of rupture be prolonged.

Report of Committee on Topic No. 6

WHAT IS THE BEST TYPE OF SIDE SHEET TO BE APPLIED TO NARROW AND WIDE FIREBOXES OF LOCOMOTIVES; DEPRESSED, CORRUGATED, VERTICAL, LONGITUDINAL OR STRAIGHT?

C. R. BENNETT, Boilermaker Foreman, Pennsylvania System, 1821 Market St., Logansport, Ind., Chairman.

J. P. MALLEY WILLIAM F. FANTOM

This matter was taken up with all concerned on July 13th, 1920, and regret to say that no one except J. P. Malley was heard from. He has covered the subject thoroughly on every point and in accord with my views and consideration in the following:

Depressed, corrugated, vertical or longitudinal side sheets have been manufactured to overcome short life of sheets, cracks and defective and leaky staybolts without success; therefore, we recommend that straight side sheets be maintained wherever possible and in following this practice, locomotives be equipped with side sheet in the same manner as when received from the mill, free from all strains to which the sheet would be subject in the manufacture of the others referred to above, as well as having a locomotive boiler that can be washed clean.

Report of Committee on Topic No. 8

OXY-ACETYLENE WELDING

D. A. LUCAS, Prime Manufacturing Co., Railway Exchange, Milwaukee, Wis., Chairman.

H. J. WANDBERG THOMAS LEWIS

After careful investigation your committee submits the following:

We are satisfied that welding done by the oxy-acetylene process can be successfully and substantially done and give perfect satisfaction and service, with great help and saving in repairing and in maintenance and construction of steam boilers.

Care should be taken to see that a competent man is assigned to the welding; a man that is known to understand the nature of welding, and has been tried and tested out before he is put on a job of welding; that is, to stand a constant pressure as in a boiler weld.

It came to our observation that a foreman boiler maker who was responsible for a number of welding operators doing firebox or boiler welding and a lot of miscellaneous welding of different parts, picked his welders for his boiler welding, and at no time was a welder. Put in a firebox to do welding that had not been tried and tested out on several test pieces, made of boiler iron, and had them tested or pulled to determine the quality of the weld.

If the tests justified putting this welder on firebox or boiler welding, he was started out under the direction of an older and experienced welder who stayed with him through the job.

We find that successful welding has been done on all stayed portions of the boiler. It is not necessary to enter into details here as this subject has been before the Association several times and all are acquainted with different kinds of welding.

We wish to call attention to an article from the ***Boiler Maker*** and the *Railway Mechanical Engineer* entitled "The Status of Autogenous Welding." "Tests on Welded Pipe" appeared in the August, **1920**, issue and "The Status of Autogenous Welding" in the July issue. These tests were made since our last meeting in May, **1920**.

We feel justified in recommending oxy-acetylene welding as one of the best known methods of repairing and building boilers.

Report of Committee on Topic No. 9

ELECTRIC WELDING

H. H. Service, Supervisor of Welding, A. T. & S. F. Railway, 308 Jefferson St., Topeka, Kan., Chairman.

I. J. Pool R. W. Clark

1. The responsibilities of good welding depend largely upon the skill and experience of the operator.

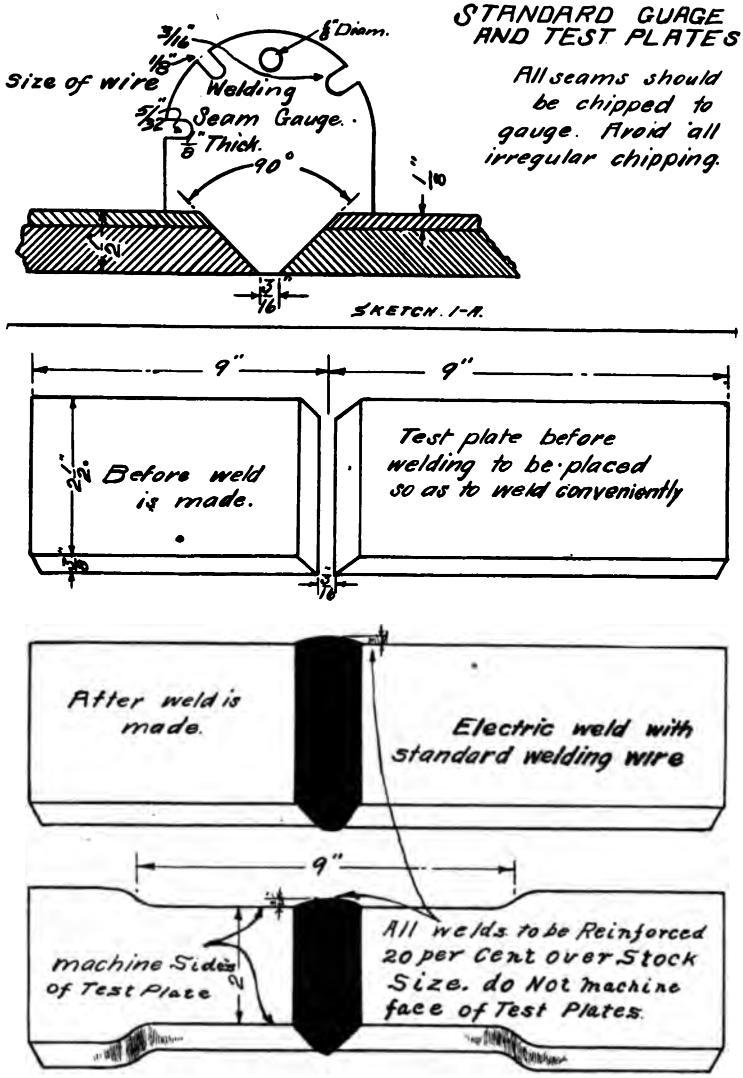
2. The use of welding electrodes that have the approved chemical contents or elements which will give the best tensile strength conditions may require, should be adopted for this purpose. Another important point is that welding electrodes which are to be used on firebox welding should have even flowing qualities; that is, the globules of metal should flow from the point of electrodes to work in a steady stream, so as to not interfere with the skill of the operator or the functions of the electric arc. The efficiency of the operator should be fully determined before he is allowed to perform any welding in locomotive fireboxes by having him weld specimens at least once each month as shown in sketch 1. The welded specimens should be forwarded to the engineer of tests who will test same for tensile strength. The efficiency of the welded specimen should be at least 75% of the firebox steel used, before operator is allowed to do any firebox welding.

It is important that good judgment should be exercised in assigning operators to autogenous welding in fireboxes.

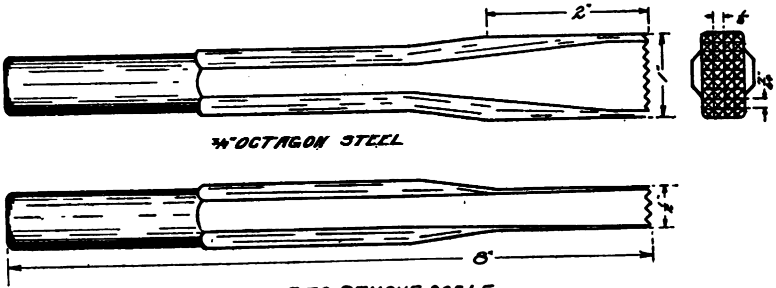
3. Another important feature is that no piece of work should be welded unless it is properly prepared. That is, all seams should be beveled as per sketch 1 and should be thoroughly cleaned, free from grease, rust, scale and other foreign substances. It is very essential that the weld be made on bright clean metal and that this condition must be preserved throughout the entire welding operation. The use of a roughing tool as shown in sketches 2 and 3, or a sand-

blast machine, may be used for cleaning purposes. All seams should be carefully fitted and beveled to 45 degrees, not allowing more than ¼ inch or less than $\frac{3}{16}$ inch space at the bottom of the V as shown in sketch 1A, and can be determined by use of a gauge.

If opening at the bottom of the V closes to less than $\frac{3}{16}$ inch, the welder should stop and have it chipped to the standard opening. Under no conditions should the plate be burned with the cutting blow pipe to enlarge the opening, unless it is going to be chipped afterward.

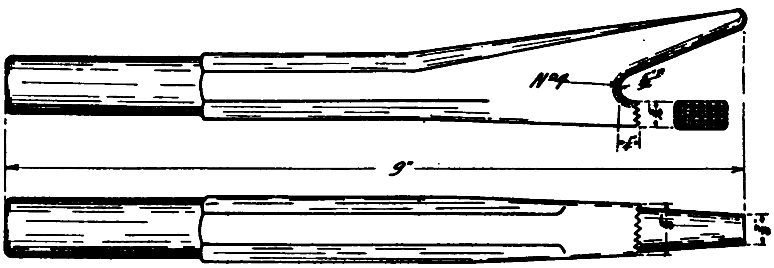


SKETCH 1



USE TO REMOVE SCALE

SKETCH 2



¾" OCTAGON STEEL
USE TO REMOVE SCALE
AROUND FLUE BEAD

SKETCH 3

The following is an approximate comparison of the cost of labor between applying an electric welded three piece Mikado firebox and riveted box of same type.

ELECTRIC WELDED FIREBOX

	No. of Men	Rate per Hour	No. of Hours	Cost of Labor
Laying out firebox wrapper sheet with templet complete..	1	.90	5	$4.50
Punching wrapper sheet........	2	.85 .62	9	13.23
Laying out flue sheet complete........	2	.90 .62	7	10.64
Punching flue sheet complete........	2	.85 .62	5	7.35
Punching door sheet complete........	2	.85 .62	3	4.41
Flanging flue sheet under press........	4	.90 .67 .67 .67	1	2.91
Flanging door sheet under press and door hole by hand...	4	.90 .67 .67 .67	2	5.82
Rolling wrapper sheet........	2	.85 .62	3	4.41
Sheering wrapper sheet........	2	.85 .62	1	1.47
Sheering flue sheet........	2	.85 .62	½	.74
Sheering door sheet........	2	.85 .62	½	.74
Burning flange on flue sheet........	1	.90	½	.45
Burning flange on door sheet........	1	.90	½	.45
Chipping flue sheet for welding........	1	.85	3	2.55
Chipping wrapper sheet for welding........	1	.85	5	4.25
Chipping door sheet for welding........	1	.85	2½	2.13
Fitting firebox for welding........	3	.85 .62 .62	4	8.36 8.36
Electric welding in door sheet and flue sheet complete.....	1	.90	28½	25.65
Total........				$100.06

DELINQUENT MEMBERS

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For riveted firebox. The operation is approximately the same after eliminating the welding and adding the following:

	No. of Men	Rate per Hour	No. of Hours	Cost of Labor
Laying out of rivet holes in flue sheet	2	.90 .62	1½	$2.28
Laying out of rivet holes in door sheet	2	.90 .62	1½	2.28
Laying out of rivet holes in wrapper sheet	2	.90 .62	2	3.04
Punching rivet holes in wrapper sheet	2	.85 .62	2	2.94
Punching rivet holes in flue sheet	2	.85 .62	2	2.94
Punching rivet holes in door sheet	2	.85 .62	1½	2.21
Counter sinking rivet holes	2	.85 .62	2	2.94
Reaming rivet holes and changing bolts	2	.85 .62	5	7.35
Riveting firebox	4	.85 .85 .62 .62	5	14.70
Corking firebox inside and outside	1	.85	6	5.10
Total				$45.78

Cost of Labor—Riveted firebox	$120.19
Cost of Labor—Electric welded firebox	100.06
Saving of welded box over riveted box	20.13

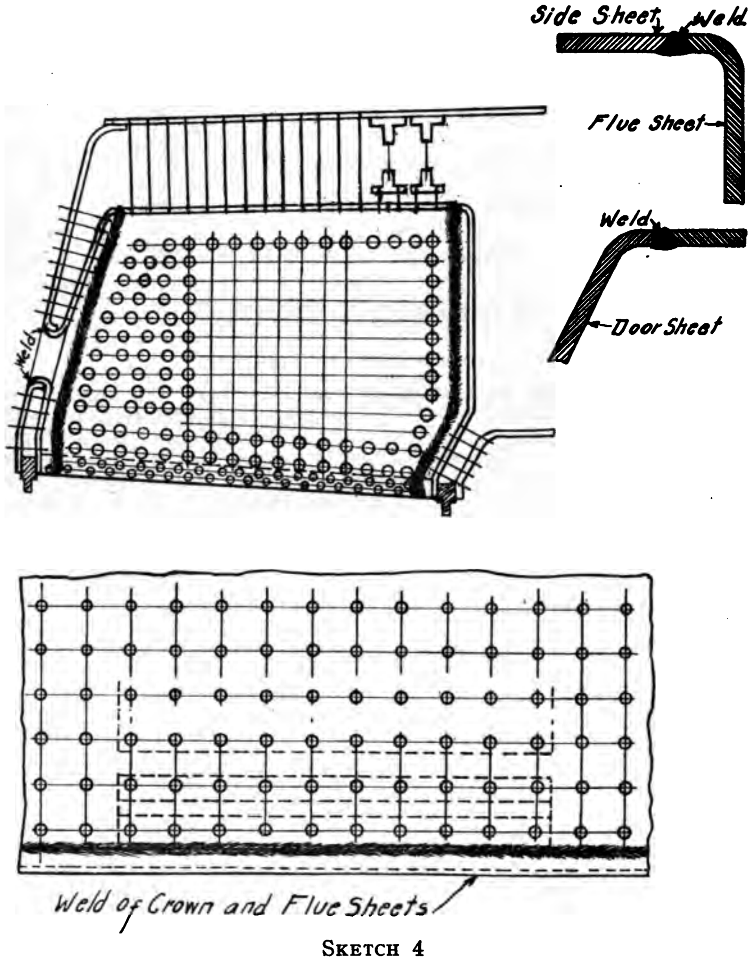
Welding of Complete Fireboxes

All sheets should be beveled on rivet line from the fire side as shown, and plates should be fitted into mud ring, held together with strong backs or clamps about every 12 inches in order to hold the plates in perfect line. The sheet should then be tack welded between each of the clamps, these tacks being from two to three inches wide. After this operation has been performed, clamps should be removed and intermediate spaces welded. Do not remove firebox from the ring until after the welding has been completed. All seams should be reinforced 20% thickness of the firebox sheet on the fire side and when it is possible to do so, seams should be reinforced on the water side approximately 10%, especially on the crown sheet.

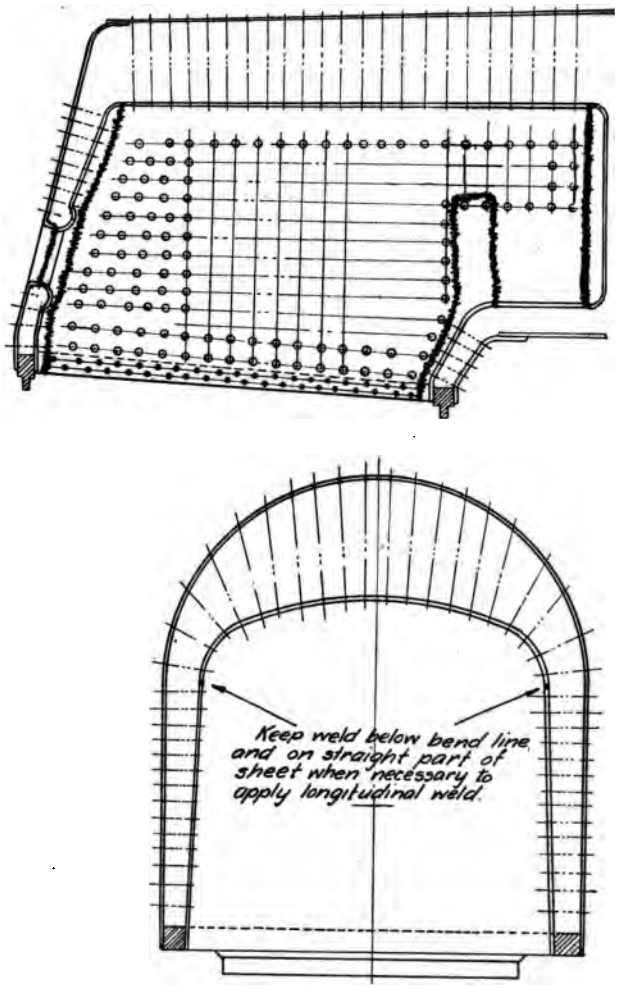
All welding should be started at the bottom of each intermediate space and finish at the top of seam. For all firebox work current values from 100 to 125 amperes will give the best results when properly handled by the operator using a $\frac{5}{32}$ inch diameter electrode. The cost of welding firebox seams per lineal foot is 90 cents for labor, material and current.

Preparing Half Side and Door Sheet for Autogenous Welding—Electric Arc Process

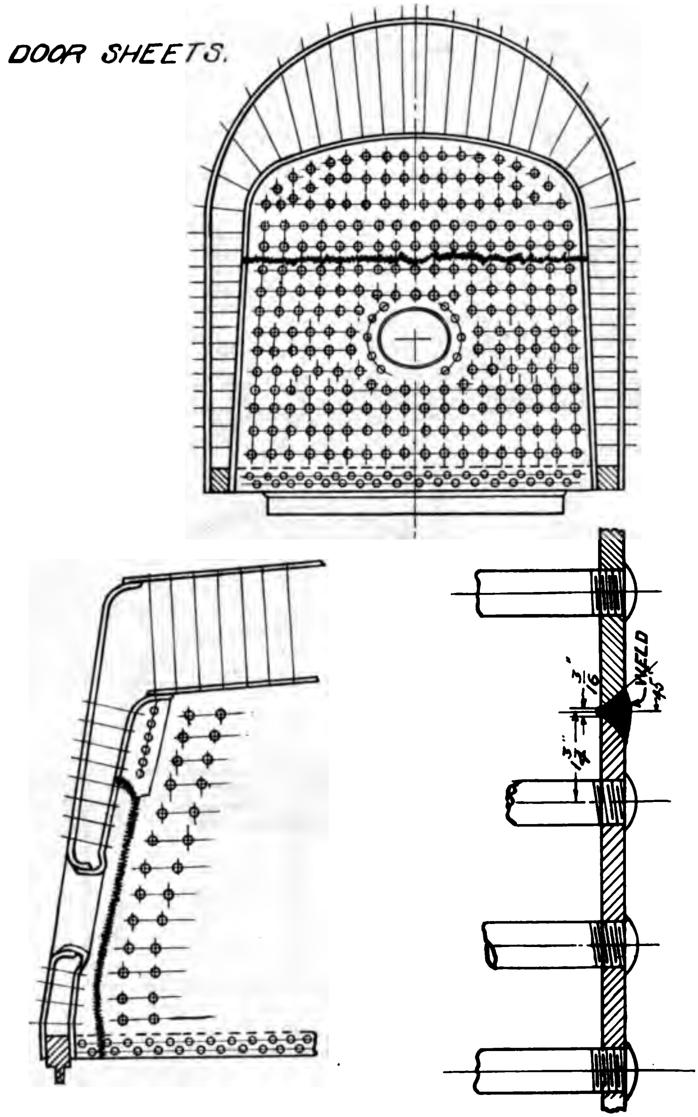
The sheet should be bolted to mud ring after it has been properly beveled and fitted to place. Staybolts may be applied except the rows adjacent to the seam which is to be welded. All horizontal seams should be held in place with strut bolts and tack welded every 12 or 14 inches. Then weld intermediate spaces alternating from the center space to space at either ends. Vertical seams should be tack welded similar to horizontal seams. After being tacked start welding at the bottom space and finish at the top space. Current values for successful welding on this operation are the same as for firebox welding described in sketch Nos. 4 and 4-A.



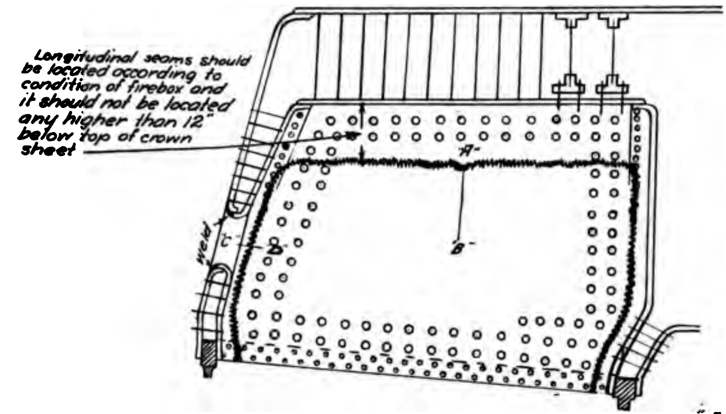
Sketch 4

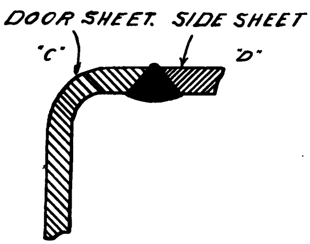

Keep weld below bend line and on straight part of sheet when necessary to apply longitudinal weld.

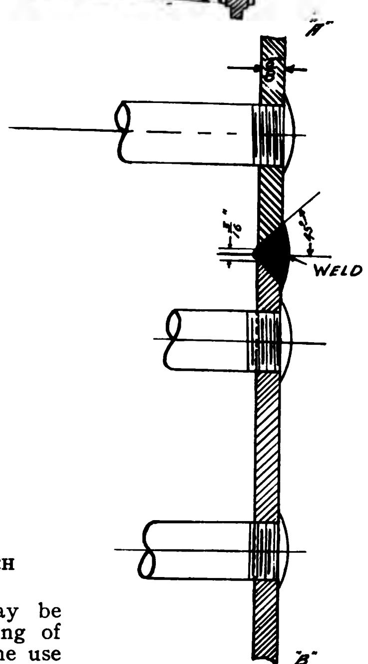
SKETCH 4-A



SKETCH 5





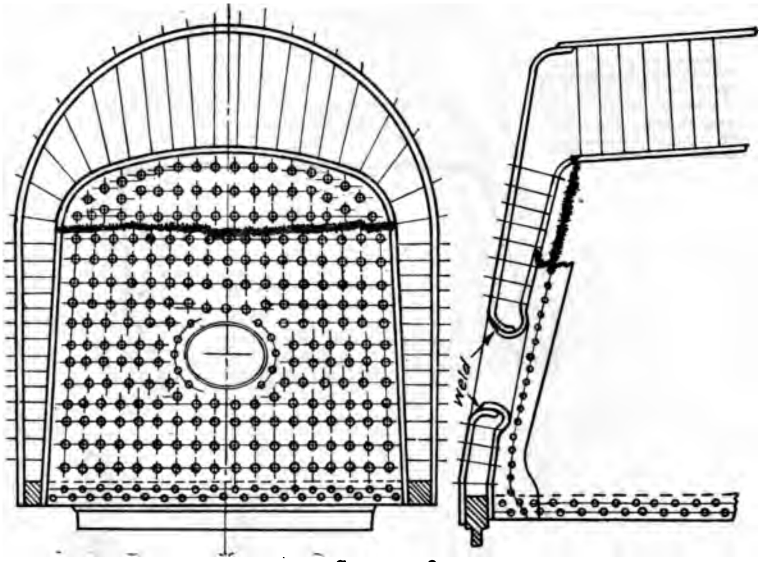


SKETCH 5-A

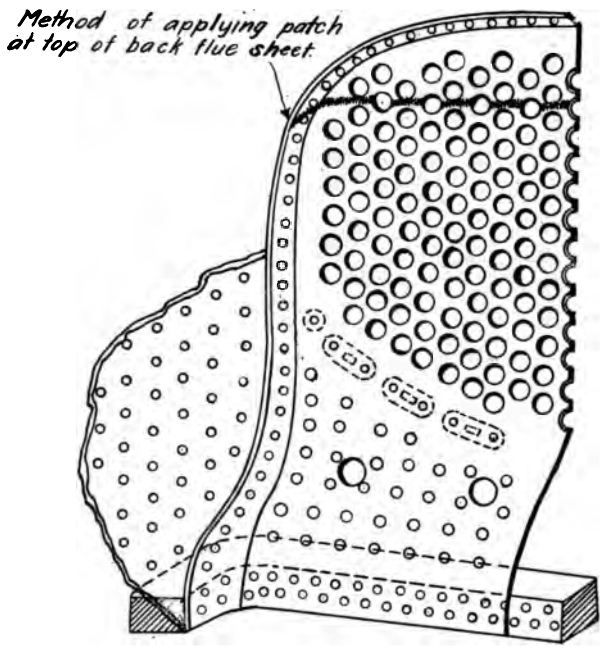
FIREBOX SHEET KNUCKLE PATCH AS PER SKETCH

Preparation for this patch may be followed as outlined for the welding of half side sheets or door sheet. The use of strut bolts can be applied to hold the patch in line when necessary, while same is being tack welded. All strut bolts should be removed after the patch is welded into position. Under no circumstances should knuckle patch be less than 12 inches from the crown sheet.

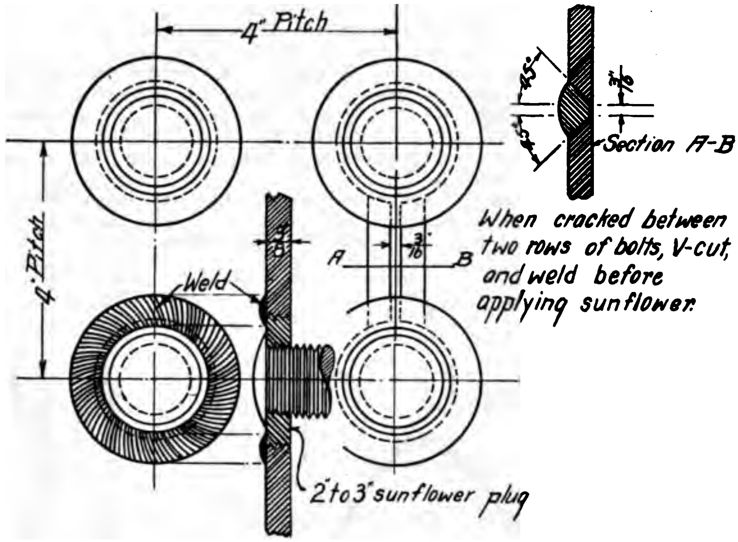
Weld the horizontal seam first, then tack weld flanged sheet to wrapper sheet. Remove all strut bolts and weld intermediate spaces, working from the bottom on either side of patch upward, finishing at top.



SKETCH 6



SKETCH 6-A



Note:—

The above method to be used to repair cracks at staybolt holes in firebox sheets, where not more than 6 sunflowers are necessary to complete repairs, and not more than 4 sunflowers will be joined together. This system may be used in main shop general repairs — sunflowers not to exceed 3" in diameter.

Electric Welding of Sunflowers and Cracks in Firebox Sheets.

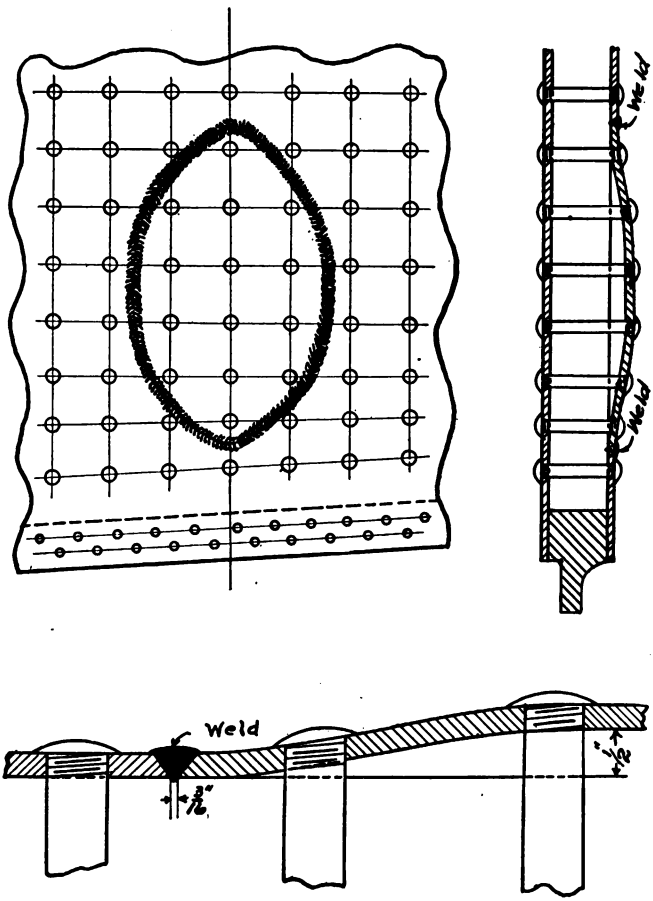
SKETCH 7

REPAIRING SMALL PORTIONS OF SIDE SHEET WHEN THEY BECOME DEFECTIVE

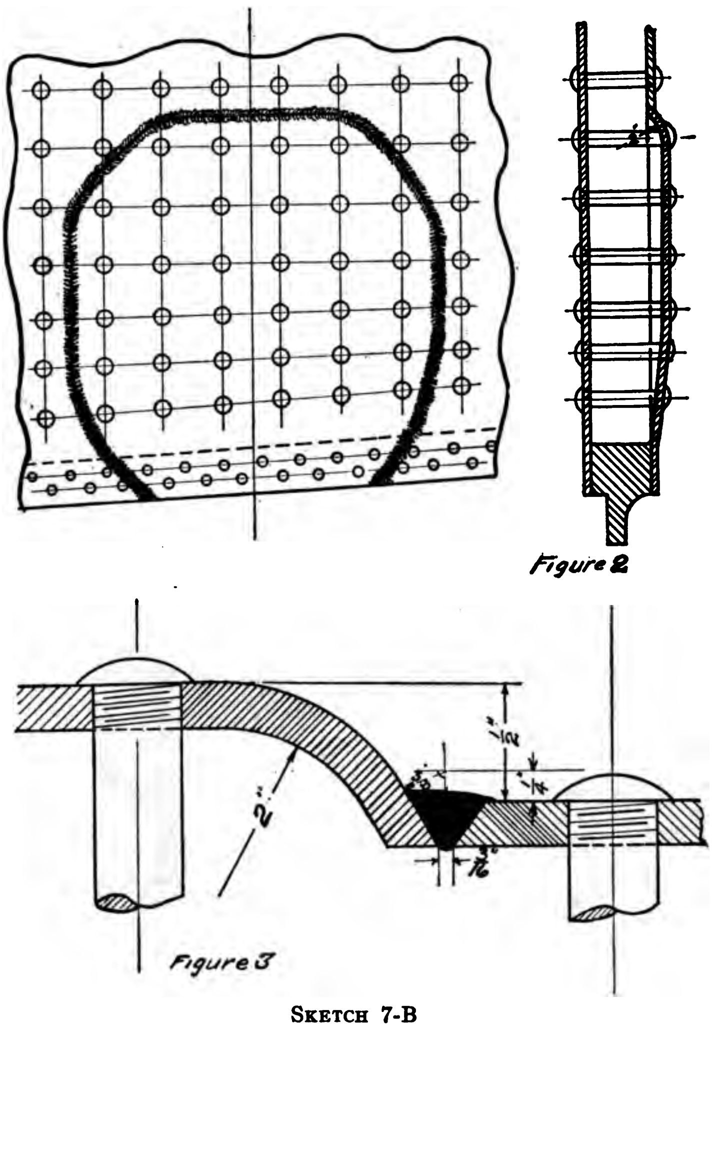
When the defective portion does not extend over six staybolts repairs can be made as per instructions on sketch No. 7, which gives very efficient results. When the defective portion is larger it is then advisable to use methods as shown on sketch 7-A, by removing the defective portion and applying a patch of an elliptical or circular shape. In preparing the patch sufficient metal should be allowed so that when the patch is dished 3/8 to 1/2 inch in the center the opening at seam should not be more than 1/4 inch wide at the bottom of "V" and not less than 3/16 inch. The patch should be held in place by strut bolts and tack welded on the right or left side; then weld this seam of patch before the opposite side is tack welded, so as to allow

the patch to draw in one direction. After this has been completed allow it to cool before starting on the opposite side. By so doing you have only one contraction on patch. All welding should be performed from the bottom upward. Should the defective portion of side sheet extend down to mud ring rivets, apply patch as per sketch 7-B, welding operations same as outlined for sketch 7-A. Should the defective portion be at a location as shown in sketch 7-D, seam may be applied as per line "A."

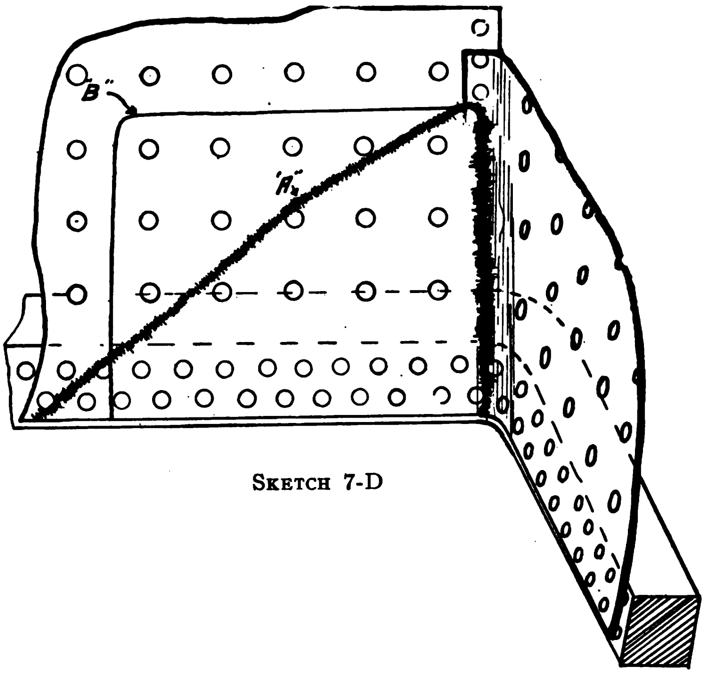
Should the plate at corner of fireboxes become defective and it is necessary to remove a portion of side sheet and door sheet it is advisable to apply a patch to both sheets as per sketch 7-E.



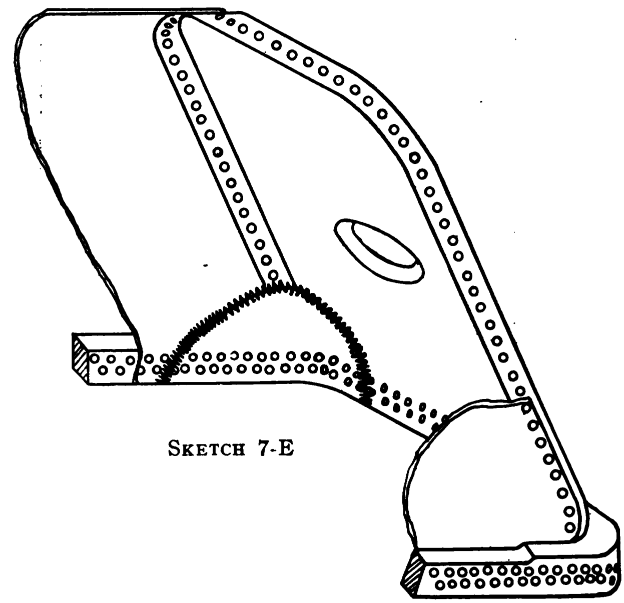
Sketch 7-A



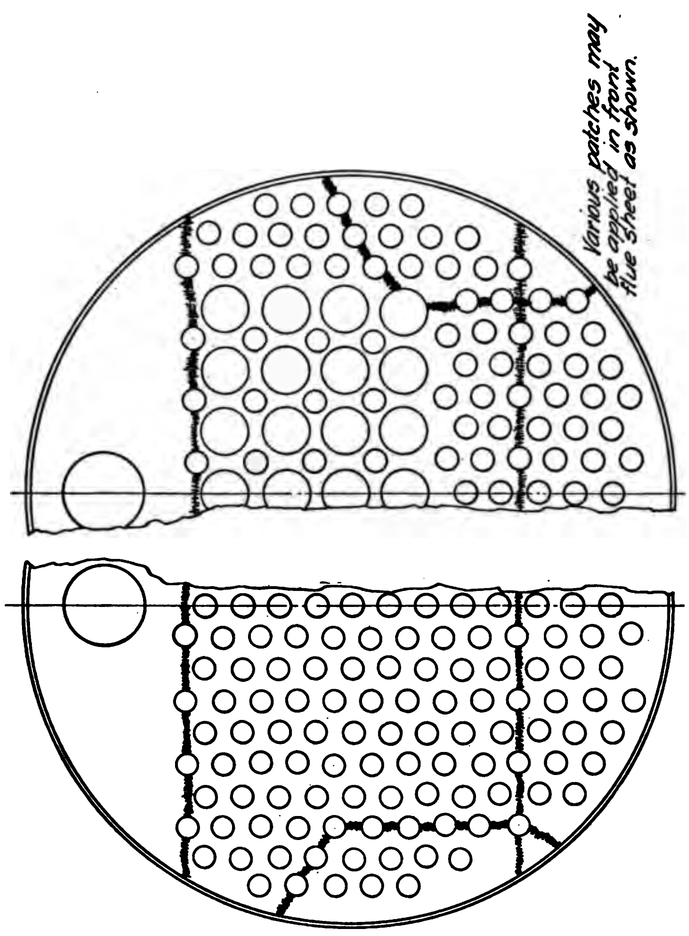
SKETCH 7-B



SKETCH 7-D



SKETCH 7-E



SKETCH 8

METHOD OF WELDING PATCHES IN FRONT AND BACK FLUE SHEET

Should it be necessary to make repairs according to sketches 8, 8-A and B, the preparation should be followed as outlined for the methods of sketch 6 and 6-A, welding same from the fire side of sheetes and reinforcing same on the water side.

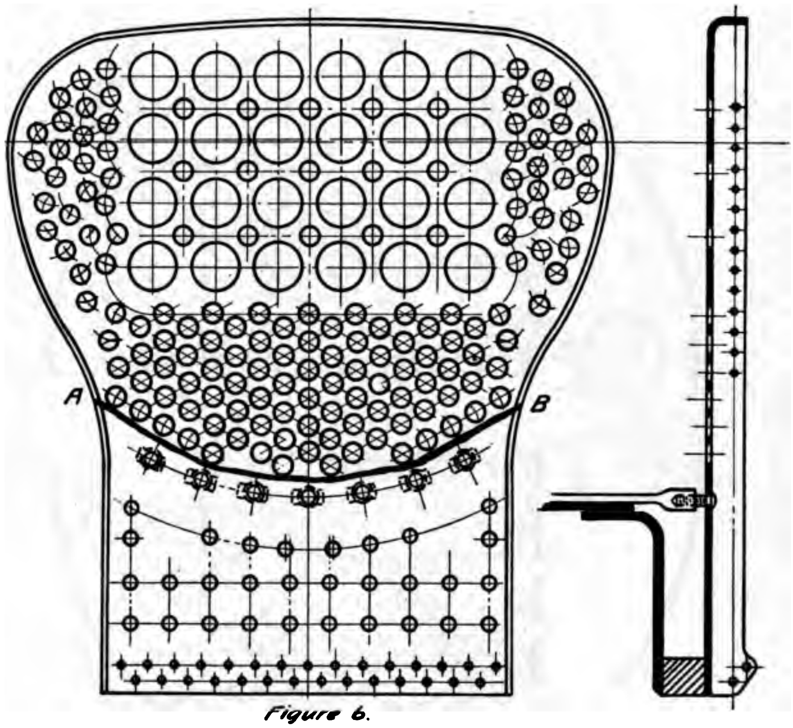


Figure 6.

NARROW FIRE BOX

This sketch represents back flue sheet with the original bottom portion and new top portion arranged for Schmidt superheater.

SKETCH 8-A

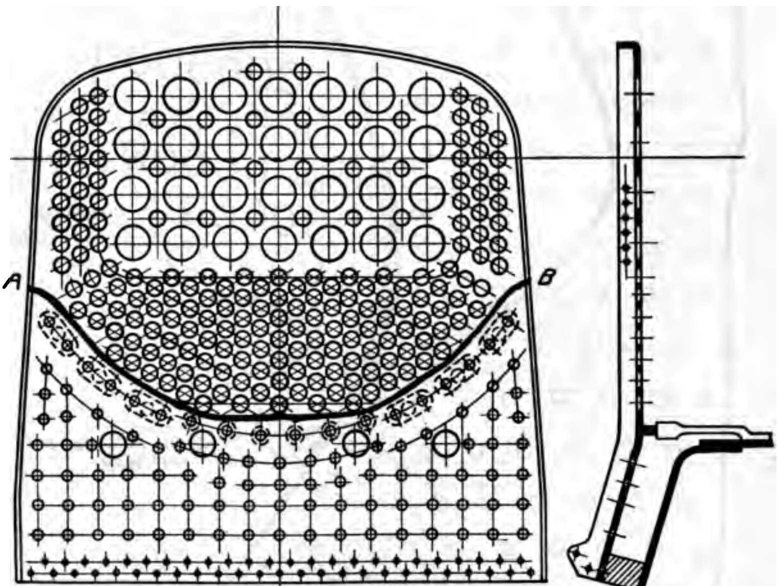
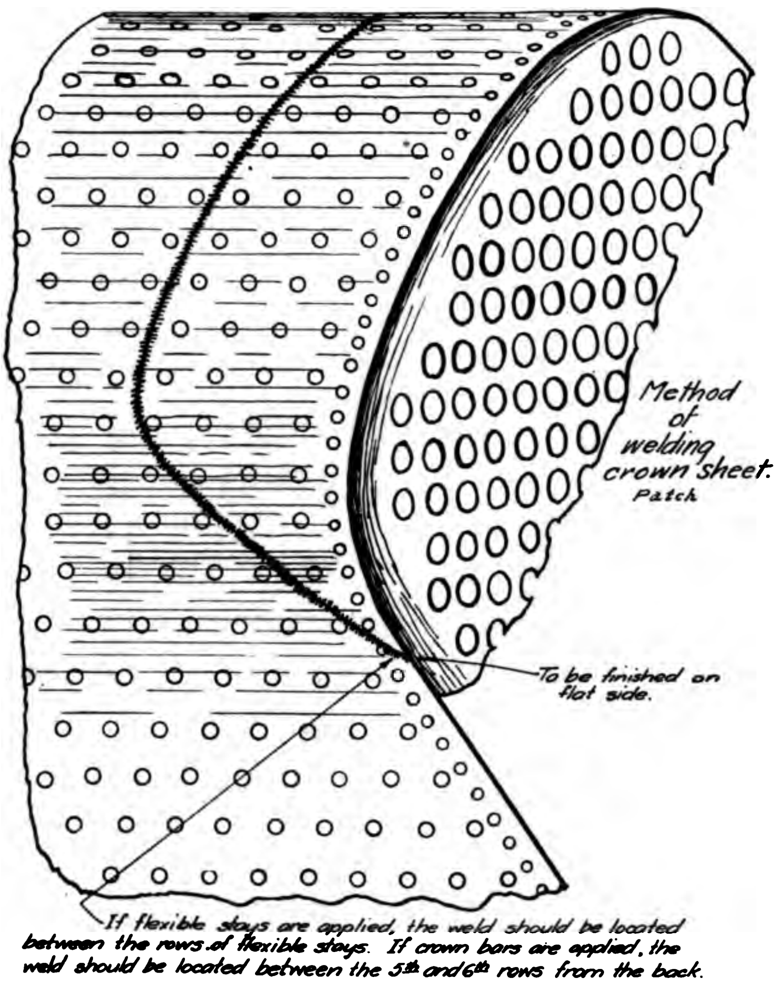


Figure 3.

WIDE FIRE BOX

This sketch represents back flue sheet with the original bottom portion and new top portion arranged for Schmidt super heater.

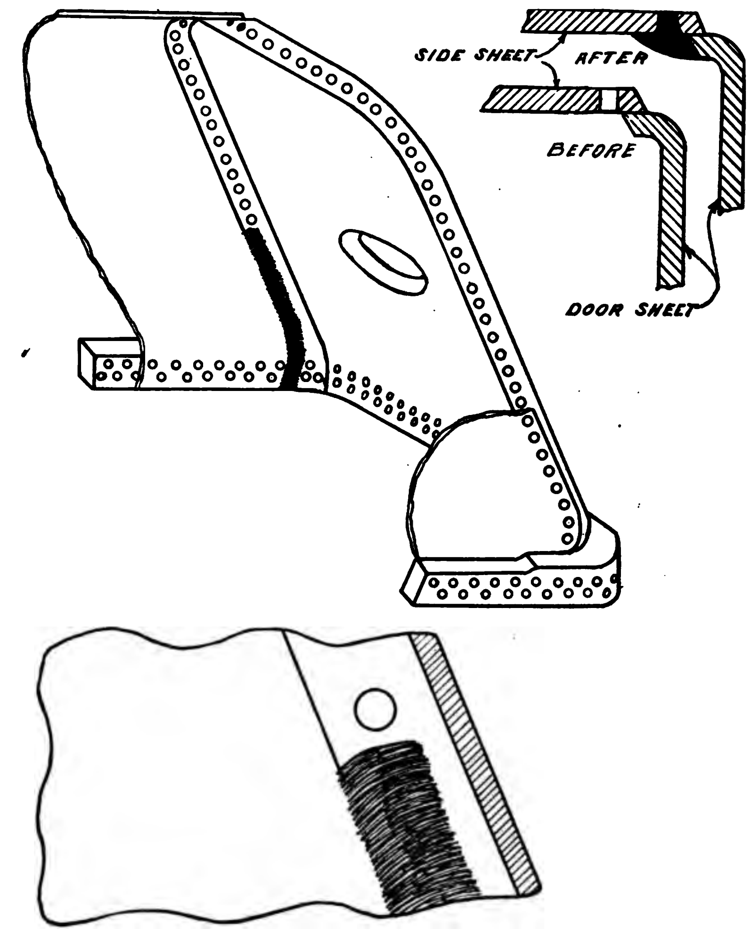
SKETCH 8-B



SKETCH 9

METHOD OF WELDING PATCH ON FRONT OF CROWN SHEET

Should it be necessary to repair the front portion of crown sheet as shown in sketch 9, prepare same for welding as outlined in sketches 4-A and B. A very important feature about this welded seam is that the front point adjacent to the flue sheet should be finished on the flat side of firebox at least 12 to 14 inches below the highest point of crown sheet.

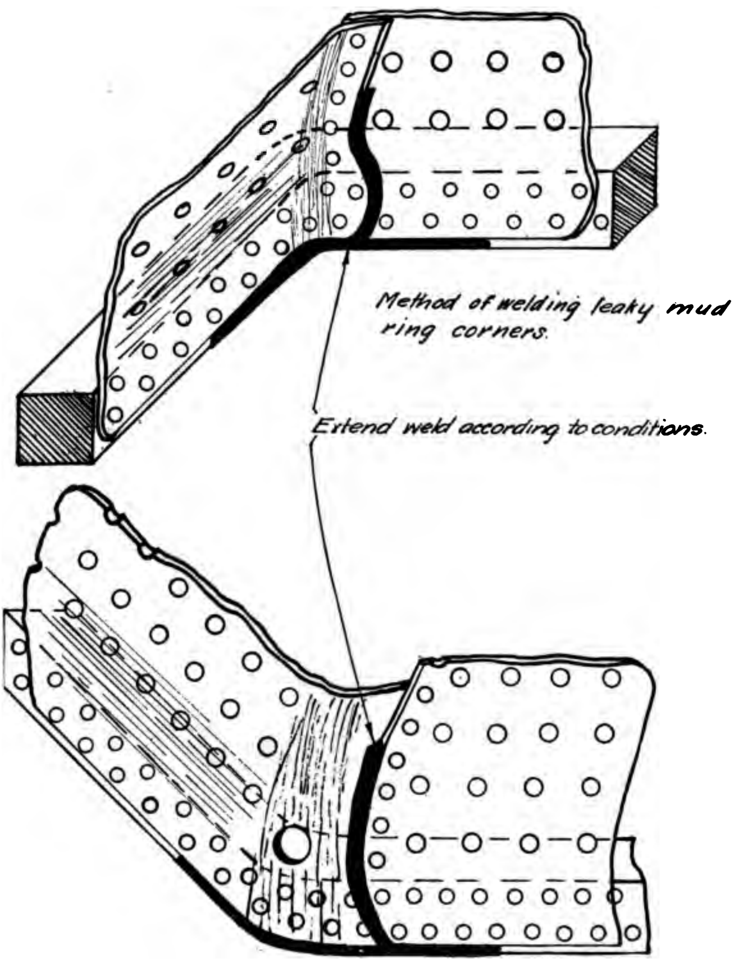


SKETCH 10

WELDING OF SEAMS

Should the seams become defective and cause considerable trouble repairs can be made with electric arc process as shown in sketches 10 and 10-A.

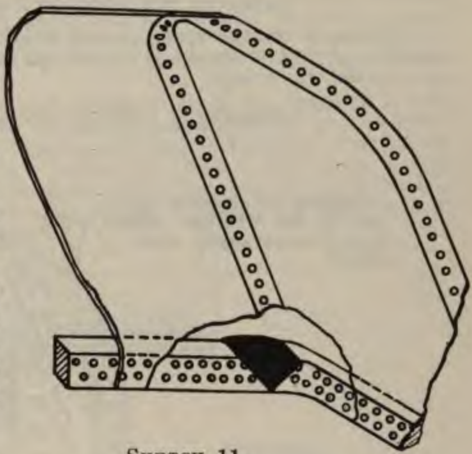
By removing defective portion of flange which is giving trouble through the back of rivet holes, bevel sheet 45% and tack weld same every 12 inches; then weld intermediate spaces. The weld should not be any thicker than flange of sheet and taper to a point and weld the old rivet hole solid as shown in sketch.


Method of welding leaky mud ring corners.
Extend weld according to conditions.

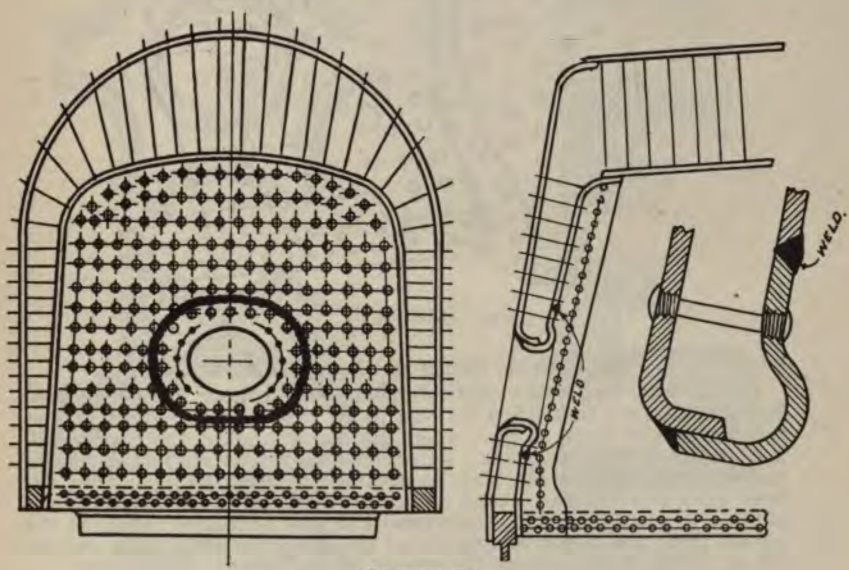
SKETCH 10-A

Broken Mud Ring

In case mud rings become broken it is advisable to remove a portion of firebox sheet as outlined on sketch 11. Bevel the mud ring from the top, giving at least $\frac{1}{4}$ inch opening at the bottom of "V," and reinforce same at the bottom of mud ring after the weld has been completed on top portion, afterward applying a patch on the portion of firebox which was removed. The welding current values for welding mud rings are from 125 to 150 amperes, using electrode $\frac{5}{32}$ inch diameter.



Sketch 11



Sketch 12

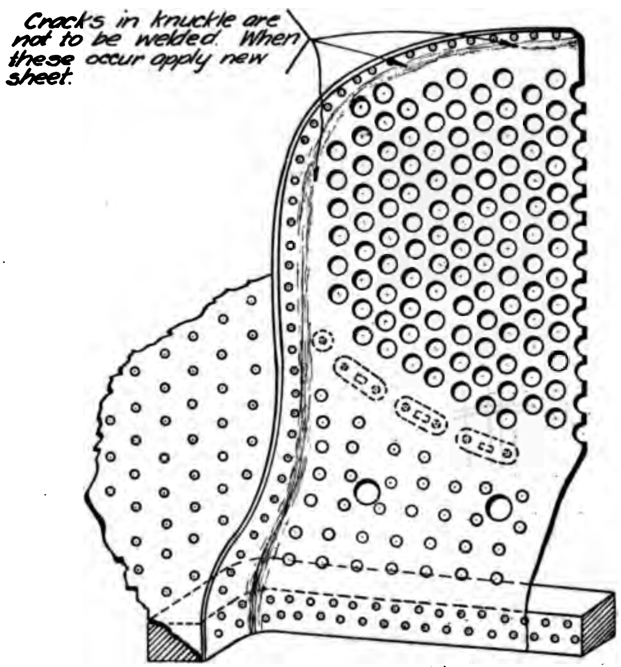
Door Collar Patch

Should the door collar become defective the defective portion can be removed and a patch applied as per sketch 12, following the instructions as described per sketch 7-A.

Improper Welding of Firebox Plates

Under no circumstances should welding be allowed directly in the knuckles of firebox sheets as shown on sketch 13. This ruling should be enforced vigorously.

KNUCKLE CRACKS IN BACK FLUE SHEET



Sketch 13

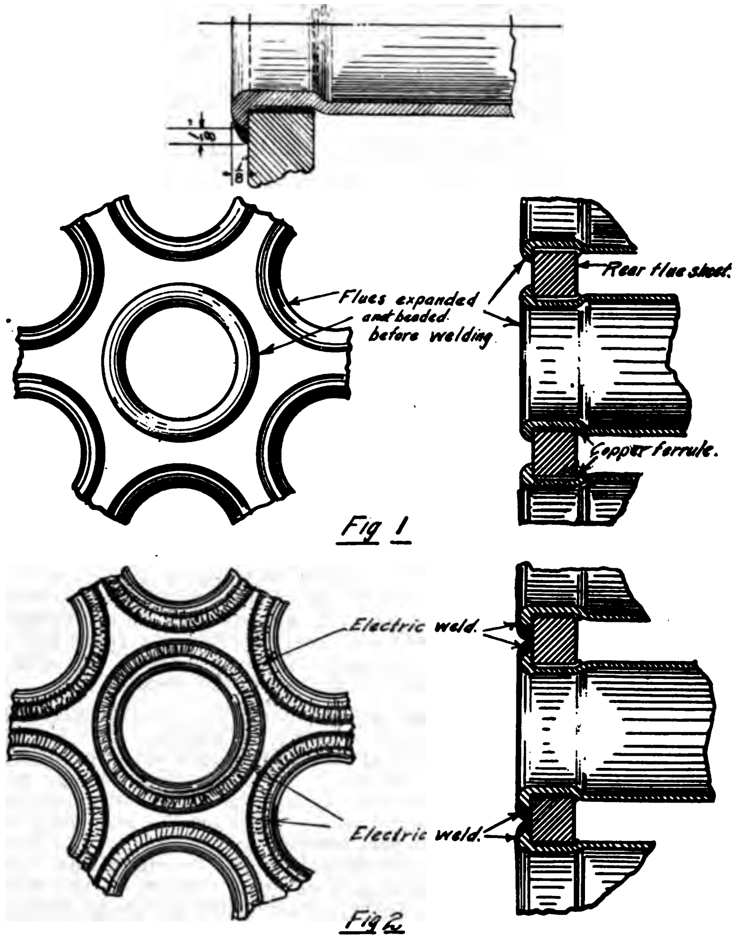
Welding of Flues in Back Flue Sheet

It is very important that when applying copper flue ferrules to flue sheet, to see that when set and rolled they do not project out on the fire side of sheet so that when the flue is applied the copper will not project under flue beads. After flues have been set in the regular manner very good results may be obtained by welding them after the flues have received the second working. That is, if the locomotive is allowed to work its regular turn until the flues are to be reworked the second time, this allows the flues and flue sheets to get a good setting. By so doing it also allows the grease to be burned off of sheet.

After the flues are worked the second time, sheets should be thoroughly sand blasted and proceeding with the welding operation, the top row of flues should be welded first, the second row next, and so on until the entire flue sheet has all the flues welded to it. It is very essential that the welding should be started at the bottom of the flue and work upward and the weld finished at top of flue to secure

satisfactory results. It is on this operation that the flowing qualities of the electrode are the most important and should be given a great deal of consideration. The heat values on this operation vary widely and the operators should use their best judgment according to conditions.

Care should also be exercised on the part of the operator not to apply an excessive amount of metal. If he should do so the metal will overheat and crack and cause a great deal of trouble. If it should become necessary to reweld a leaky flue which has been welded previously, all the old metal or weld should be removed and the flue worked tight into the sheet, after which it should be sand blasted and welded as formerly described.



METHOD OF APPLYING LOCOMOTIVE BOILER FLUES BY ELECTRIC WELDING. SKETCH. 14.

SKETCH 14

Report of Committee on Topic No. 10

LAW

GEORGE W. BENNETT, District Inspector, I. C. C., 15 Kent St., Albany, N. Y., Chairman.

JOHN WINTERSTEIN A. N. LUCAS

Your committee recommends the adoption of the following addition and amendment to the Constitution and By-Laws:

ARTICLE XVIII

LIFE MEMBERSHIP

Sec. 1. Any member who has been active for ten consecutive years shall be eligible to life membership.

Sec. 2. Not more than one per cent. of the total membership shall be made life members in any one year.

Sec. 3. The executive board shall decide upon the merits of all applicants.

Change present Article XVIII to Article XIX.

Report of Committee on Topic No. 11

ADVANTAGES AND DISADVANTAGES OF TREATED WATER

T. P. MADDEN, G. B. I., Missouri Pacific Railroad, 6947 Clayton Ave, St. Louis, Chairman.

GEORGE AUSTIN E. W. YOUNG

Your committee submits the following report as a result of investigations of the subject assigned.

INTRODUCTION

In an address before the New York Railroad Club on April 20, 1917, and the Western Society of Engineers at Chicago, on April 29, 1920, it was estimated that an average of 625,000,000,000 gallons of water are used on American railroads each year and of this amount, 450,000,000,000 gallons are used by locomotives for making steam. Following these figures a little further and taking two pounds per thousand gallons, which is a conservative average of the amount of scale usually found in water supplies, we have the total amount of 900,000,000 pounds, or 450,000 tons of scale annually going into our locomotive boilers, the greater part of which, unless removed by chemical treatment, will adhere to the tubes and sheets.

Approximately 60,000 engines are using this water which would mean an average of 1,500 pounds of scale per engine. This would be equivalent to a coating of about one-eighth inch on the tube and sheets of a Mikado type locomotive. A conservative average would cause a five per cent. fuel loss which would amount to an annual total of 15,625,000 tons of coal in addition to the short life and leaky flues, staybolts, and fireboxes with the incident great expense and loss of engine time. These figures will show that the condition and quality of the water used by locomotives is of great concern to the railway managements in general, and to the master boiler makers in particular.

QUALITY

But very few good boiler waters are found naturally and the railroad is indeed fortunate where these possibly can be secured. The

proper development of such supply warrants considerable expense as it assures constant good performance in boilers with the elimination of the cost and uncertainty of any treatment.

Water is secured from wells and surface supplies such as streams and lakes. The quality of the well waters varies considerably, even, at times, in wells of close proximity. The well waters as a rule are clear, but similar to the mythical purity of the sparkling spring water, this clearness in most cases conceals unexpected troubles in the shape of dissolved injurious, incrusting salts. Fortunately, chemistry has so developed that the amount and extent of their properties can be accurately determined by short laboratory tests and it is no longer necessary in the development of new supplies to have the engineer wire back to the dispatcher from the next station that water is good and then find it necessary to renew the flues in a few months. Although the dissolved solids are low, streams at most times carry enough sediment and dirt so that there is visible evidence of portending trouble and care is taken accordingly. It is the clear waters that should warrant investigation.

The common constituents carried by water are generally known as "lime," "gyp" and "alkali." The "lime" refers to the carbonates or soft forming scale; "gyp" is applied to the sulphates or hard scale, and "alkali" to the miscellaneous dissolved salts, mainly sulphate and chloride of sodium which do not precipitate at ordinary boiler water concentration. A detailed description would involve a lengthy report in itself and is not within the province of this report.

Treatment

A perfect boiler water is one which will allow the tubes to run the full government amount with but a white wash coating of scale, and will cause no delays to locomotives attributable to water conditions, with but minimum attention at terminals. Where impossible to obtain naturally this condition can be approximated by proper treatment as has been conclusively demonstrated. There is no question concerning the advisability of removing the scale with its corresponding trouble, chemically, thereby conserving labor and material for more important needs as well as securing the numerous attendant benefits in the improved locomotive performance. The character and type of treatment is necessary to be settled locally and is more a question of comparative costs. It should be followed up by a department especially organized and responsible for this work if best results are to be uniformly obtained.

Interior treatment by means of boiler compounds were probably the first method of water treatment. These undoubtedly accomplished efficient results in many cases. There is no "cure-all" for boiler troubles, and it is usually inadvisable to put into boilers promiscuously, compounds of a secret composition except under the direction of a chemist. All compounds have the universal disadvantage of precipitating the scaling solids in the boiler and making a sludge tank out of the locomotive.

Soda ash, the commercial carbonate of sodium, is probably the most common chemical used as a scale preventive. Its action is on the "gyp" or hard scale and similar to the action of boiler compounds throws down the scale as sludge which can be blown out of the boiler. Several large western railroads have obtained remarkable results by the treatment of water in wayside tanks with this material alone and following up the results with chemical tests to see that proper amounts are used regularly. The increased flue mileage has been very

marked. It has also been found a big help where used in predetermined amounts direct into boilers or engine tanks at terminals. The disadvantage is the tendency to induce foaming from the suspended matter thrown down in the boiler. It has also caused some disfavor where it has been used without chemical direction in greater or lesser amounts than necessary with the corresponding foaming troubles or lack of scale removal. However, experience has shown that very efficient results can be secured under competent direction.

Complete treating plants give the most efficient and satisfactory means of handling bad water propositions. In these the scale and injurious impurities are removed and settled or filtered out and a good clear, soft water given to the locomotives. The only disadvantage in this method of treatment is the high initial expenditure, but this is warranted in most cases by the large return on the investment in decreased fuel consumption, increased life of flues, staybolts and fireboxes, reduction in necessary repairs, and increased availability of locomotives with the attendant improved performance. Results from complete plants have not come up to expectations in some instances, but this has been found due to the fact that there was a belief that the initial expenditure and installation of the plant would settle all difficulties, whereas the correct and uniform operation is the real problem which requires regular supervision and attention. It has been found best to equip an entire engine district rather than isolated stations; but on the other hand, so much scale in the bottom of a treating plant instead of on the flues and sheets is so much trouble avoided.

Treatment of water for its foaming qualities is usually in the engine tank with an anti-foaming compound, which is essentially a weak acid emulsion of castor oil so prepared that it will mix uniformly with the cold water in the tank. It is prepared on some railroads by their chemical department, but in most instances, it is purchased as a proprietary compound. It is within the province of this Association to call attention to the danger in the use of crude or mineral oils for this purpose on account of the large amount necessary to check foaming and the liability of formation of oil scum on the hot sheets, which is much more injurious than scale of many times the thickness and may result in bagged sheets.

In connection with water treatment as well as railroad water supply in general, it may be well to call attention to the advisability of having the responsibility for the quality and condition of a railroad water supply centered in one department which should work in close co-operation with the mechanical, engineering, maintenance and operating departments, and so co-ordinate the work that the utmost advantage is taken of all conditions, and with constant and effective supervision remarkable results are assured.

ECONOMIES

With the advent of the heavy type of power and the large investment involved, the importance of continuous availability of the locomotives has been accentuated. The brick arch, superheater units, and front end rigging have made work on flues more difficult and requiring longer time. The advisability of so treating the water as to eliminate leaky conditions and avoid tying up this machinery, is generally recognized. Even the best of boiler work cannot eliminate engine failure on the road due to leaks, whereas experience has shown that by water treatment this is but one of the numerous advantages. Much has been said concerning the increase in foaming from the use of treated water and this argument is frequently advanced against

such improvements. By proper treatment of the water in correctly designed softening plant there is but little if any increase in foaming tendency while with compound of soda ash treatment, this tendency can be minimized by judicious use of blow-off cocks without detriment to the performance of the locomotive. Attention is often called to the evident fuel loss from hot water wasted in blowing off, without consideration being given to the much greater saving that is being made by the removal of the insulating scale from the heating surfaces, which far outweighs the slight blow-off loss, in addition to making the large boiler maintenance savings.

A questionnaire was submitted by the committee to the genera boiler inspectors of the leading railroads and 10 answers were received covering experience and results on most of the territory in this country with the exception of the southeastern section. It appears that the northeastern section is not greatly troubled with water quality, but in the central and western sections waters of extremely bad quality for boiler purposes are frequently encountered and treatment has been applied with good results.

The following is a list of the questions submitted with a summary of the answers immediately following the respective question:

Q—Do you use treated feed water in your territory; if so to what extent?

Answers show that waters are treated from occasional application of compounds to as high as 50% of regular treatment. There are 125 complete on the Santa Fe, 78 on the Great Northern, 73 on the Missouri Pacific, while some roads have occasional plants and others have complete equipped engine districts.

Q—Do you treat feed water to prevent formation of scale, corrosion, or foaming?

This developed that in most cases water was treated to remove the scale and in some instances corrosion. Four of the 10 reported all three.

Q—Is treatment applied to wayside tanks or by direct injection into boilers?

Where water is handled by the complete treatment, this is done in wayside tanks. In some cases of well developed soda ash treatments the chemical is added to wayside tanks. The C. B. & Q. has about 50 per cent. of its water treated by this method; the Wabash, 118 plants and development is under way on the Frisco and Alton. Some compounds are applied direct to engine tanks immediately after washouts and others to the engine tanks. In some cases soda ash treatment is handled in a similar manner.

Q—Do you find that water treatment increases or decreases the mileage between washouts?

Eight of the 10 replies indicated an increase while two advised no change. Where muddy water is treated or soft scaling waters there should be an increase in mileage. Where very heavy "gyp" waters are softened with soda ash or compounds the alkali salts are increased to such extent that more frequent washouts are required unless care is taken in blowing off.

Q—What, if any, has been the increased life of flues, staybolts, and fireboxes since the adoption of treated water?

This increase varies from 15 to 300 per cent., depending on the character of the raw water. It appears that by proper treatment of the water no difficulty is encountered in obtaining the full government

allowance in the life of flues, and in cases where but eight to 12 months life was formerly secured the increase to three and four years makes a very considerable showing.

Q—Do you notice any increase or decrease in the pitting of flues or boiler plates since the adoption of treated water?

The answer to this question showed some variation and it would appear that considerable pitting is being encountered. However, on the railroads where complete plants have been installed throughout entire engine districts, we are advised that the decrease in pitting has been very marked.

Q—Do you notice any increase or decrease in the deposits of scale on the heating surface, and do you get the impression that the general performance of the locomotive is better or worse on account of the use of treated water?

The replies were all in accord in advising of a marked decrease in scale deposits and better performance of the locomotives. In complete plants the scale should be practically removed before the water is delivered to the boilers if plants are properly operated, so that in such cases a marked decrease is assured. With soda ash treatment a large part of the scale is precipitated as mud and is blown out so that it will not show up on the tubes and sheets. Advice in one case of compound treatment was that scale was much thinner but harder and more difficult to remove. The only case of no improvement in locomotive performance was where treatment caused increase in foaming tendency of the water.

Q—What are benefits as well as injuries from using soda ash direct through the tank of locomotives?

The use of soda ash is a cheap method of reducing the scale troubles and where properly used in correct amounts will greatly decrease scale deposits. However, it has the disadvantage of leaving sludge in the tank and accentuating the foaming tendency of the water with the corresponding complaints from engine crews.

Q—Have you any experience with mechanical devices for purifying boiler feed waters, either before or after they are taken into the tenders?

No experience given.

Q—To what extent, if any, does the use of treated water decrease the time of locomotives at terminals?

The use of properly treated water materially reduces the time of engines at terminals in direct proportion to the decrease in leaky conditions with the elimination of the caulking and other boiler repairs. This, of course, varies with the quality of the raw waters and makes a large saving in some instances while others are not so marked. Where an increase is obtained in mileage between washouts, this is an additional factor.

Q—What is the approximate cost of treating water per thousand gallons by methods employed on your line?

Replies showed a variation of from two to 14 cents, but costs were not based upon the same conditions. A chemical analysis of the water will show the amount of chemicals necessary for treatment and the cost can then be readily calculated for individual points from current market prices.

Q—Will the saving, if any, in cost of boiler repair due to the use of treated water more than offset the cost of treatment?

The replies where full treatment or soda ash was used were in accord that the saving would much more than offset the cost of treatment, estimates being as high as 200 per cent. In two cases where compounds were in use there appeared to be some question.

Q—Are your locomotives equipped with blow-off cocks; if so, how many and where located?

Number of blow-off cocks varied from one to three. The favorite location appeared to be on each side near front mud ring corner. However, several were located in the throat sheet and two in the R. B. corner connected with perforated pipe along mud ring.

Q—What are your instructions to engineers and others in regard to use of blow-off cocks?

The instructions as a rule called for short and frequent blow-off while on the road with longer periods at terminals. Long blow-offs should be avoided. Blow-off cocks should not be used while injectors are working and preferably while throttle is closed.

Q—Are blow-off cocks used while on the road, and at terminals?

Replies indicated both are desirable and generally in effect.

Q—What are your instructions as to method of manipulating blow-off cocks with a view to removing the greatest amount of sludge from boiler and blowing away the least amount of water?

Answer to this question was brought under No. 14 with reference to short blow-off with throttle closed and injectors off.

Q—What provisions have been made on your road and at the terminals in the way of blow-off boxes or otherwise to facilitate the use of blow-off cocks?

Many terminals have been equipped with blow-off boxes while convenient locations only are selected for blowing off on the road.

Q—Are the operating devices of the blow-off cocks so arranged that they can be operated from the cab?

It was generally agreed that this feature was very desirable and had been put into effect in many cases. The tendency appears to be to make such connections.

Q—Does the use of treated water increase or decrease injector and boiler valve trouble?

There was some variation in the replies to this question, some advising increase and others decrease. n cases where water is properly treated throughout entire engine district there appears to be a decrease in injector trouble. Where water is improperly treated or raw and treated water is mixed, as well as in the case of straight soda ash treatment, there seems to be an increase of this trouble.

Q—What, in your opinion are the disadvantages of treated water?

The only apparent disadvantage to treated water brought out is the tendency to increase foaming and if treatment is properly done this is held at a minimum. Quoting from one report which appears to fully cover the situation:

> "By the proper method of treating water, there can be no disadvantages over untreated. It is quite necessary after treating plants have been installed to place them under the charge of some department, and arrange for periodical inspections of the plants and check of the treatment. Results cannot be obtained by installing treating plants and depending on the man in charge for the proper treatment of the water."

As information on this subject, it is desired to submit a monograph by Mr. E. W. Young, giving facts which should prove of value.

We wish to take this occasion to thank the members who were so considerate as to take the time and trouble to aid the committee by returning their valuable replies to our questionnaire, and it is hoped that the discussion will bring out the results of the experiences of other members and prove a valuable addition to the available information on this subject.

APPENDIX A

By E. W. Young, General Boiler Inspector,
Chicago, Milwaukee & St. Paul Railway.

Water is said to be hard when it does not easily make a lather with soap; and on analysis such water is found to contain limestone in solution, principally either the carbonate or sulphate of lime or the carbonate or sulphate of magnesia.

When such water is kept heated to 212 degrees F. the carbonates are deposited as scale, as they are in a tea kettle; and if the water is kept heated to the temperature of a steam boiler, say from 300 to 400 degrees F., the sulphates also are deposited as scale.

If such scale is allowed to accumulate in a boiler the first effect is that the flues get hotter (they must get hotter to drive the heat through the scale into the water), and expand tight in the flue sheet, so that a moderately hard water does not make a boiler leak. But if the scale gets thicker than about a half inch, the iron will soon burn and be ruined.

On the other hand, if, while the flues are coated with scale and are hot and tight in the flue sheet, either soda ash, or tank water containing carbonate of soda (alkali water), or even the best of pure soft water, be admitted to the boiler, the scale will commence to loosen and drop off, the flues will cool and shrink in the flue sheet and begin to leak. This is the most common cause of boiler leaking, though of course, there are others such as unequal heating due to dirty fires or to a blower on a spotty fire, or several other causes.

This loosening of scale from the flues, and its becoming fine, is also the common cause of foaming. Because the scale can be loosened by soda ash or soda water (alkali water) there has been a general belief that soda in water causes foaming, but when it was found that the boiler foamed when the scale was loosened by pure soft water it became evident that it was the fine particles of scale suspended in the water which caused the foaming; and we now know that about 10 pounds of fine scale or sludge in a boiler will make the best of waters foam; and we also know that we can carry water with 400 grains of soda per gallon without foaming if the boiler is absolutely clean.

Pitting, grooving, and other forms of corrosion are now known to be the result of electrolytic action between spots in the flues or sheets of different chemical composition, or different hardness, or even different strain; but the electromotive force is so small that the currents cannot flow in anything like pure water (a poor conductor) but only in water containing more than 30 grains per gallon of some electrolyte like sodium chloride (common salt) or sodium sulphate (Glauber's salt.) And the strangest discovery of all is that a few grains of caustic soda or soda ash, added to the water, will prevent the pitting. As good an illustration as anyone can want is to be seen in the wells at Aberdeen, S. D. The hard water from 1,300 feet down has about 100 grains per gallon of sodium sulphate and eats well casing so fast that a well lasts only four or five years, but the softer water from 1,100 feet down, has about 100 grains of sodium sulphate and also 25 grains of sodium carbonate and has no action whatever on the well pipes.

When water is treated cold, it cannot usually be softened lower than three grains per gallon, sometimes five or six grains, but it will come down to two grains on heating. A little of this comes out in the injector and sticks, the remainder comes out in the ciler as a soft sludge and tends to foam after about 20,000 gallons have passed through the boiler, unless it is handled with care.

The injector, branch pipe and check can be kept as clean as new by treating the water with a little sulphate of iron in the treating plant, but this prevents the use of caustic soda or carbonate of soda to obviate pitting by deep well waters.

SUMMARY

1. Ordinarily lime and soda ash and sometimes sulphate of iron. Lime takes out carbonate hardness, soda ash sulphate hardness, and iron sulphate the part that tends to clog the injector.
2. Most of the waters require per thousand gallons five pounds of hydrated lime costing three cents and four pounds soda ash costing seven cents, or a total of 10 cents per thousand gallons for chemicals; some cost only half that much, but some, more.
3. Properly treated water will not cause foaming after the boilers are freed from scale, if only they are blown out a few seconds at intervals of an hour or so.
4. We treat to prevent scale, leaking and corrosion.
5. Improperly treated water will increase injector trouble: properly treated water will eliminate it.
6. Properly treated water nearly doubles the mileage between washouts, except in the case of deep well waters which must be changed to prevent too great concentration of sodium sulphate or chloride.

In Memoriam

TRIBUTES TO THE LATE BENJAMIN F. SARVER, J. B. BEST AND JOHN T. NEARY

The following Memorials to deceased members were filed for the 1921 convention by committees named by the President.

TO THE LATE BENJAMIN F. SARVER

The Master Boiler Makers Association records with great sorrow and keen regret the loss of a highly esteemed member and official sustained in the ending of the life of Benjamin F. Sarver of Ft. Wayne, Ind., Boilermaker Foreman of the Pennsylvania System for 27 years and in its service for more than 39 years, who passed from earth, July 23, 1920.

As one of the earliest members of this organization he had from its inception evidenced a lively concern in everything that tended to promote its growth and usefulness, and in the welfare of his fellow members.

In committee work and as a member of the Executive Board for six consecutive years, he was ever zealous, active, earnest and the personification of loyalty.

His merit in this regard was a reflex of what he was to the railroad company he so long and ably served, and to the community in which he lived. In every instance it commanded and received well deserved recognition for fidelity, uprightness and purity of life and character.

His broad vision, generous nature, genial disposition and kindly courtesy were distinctive characteristics of a worthy and well qualified man invested with the natural faculty of winning and retaining the good will and firm friendship of all who knew him.

In honoring him as it did this Association honored itself and his wise counsel and intelligent co-operation will be long remembered and often missed.

Our loss is great but that of his widow and sons is greater. In appreciation of this we respectfully tender them in their bereavement the fullest assurance that words can express of our deep and sincere sympathy, and that we individually and collectively desire to be permitted to share their affliction.

J. H. SMYTH, Chairman
C. F. PETZINGER
HARRY F. WELDEN
Committee.

TO THE LATE J. B. BEST

Whereas, It has pleased Almighty God in His infinite wisdom to call from our midst our associate member, Mr. J. B. Best, who died February 28, 1920, be it

RESOLVED, that we his fellow associates, while deeply mindful of our loss, extend to his beloved wife and relatives our heartfelt sympathy and pray that Almighty God may help and comfort them in their bereavement: Be it further

RESOLVED, that a copy of these resolutions be sent to his family and spread upon our minutes of the meeting.

J. J. DAVEY, Chairman
H. J. SCHOLLS
THOMAS BURDETT

TO THE LATE JOHN T. NEARY

It having pleased our Heavenly Father in His infinite wisdom to remove from our midst, Mr. John T. Neary, who died March 12, 1921, be it

RESOLVED, that we his associates, extend to his bereaved wife and family our heartfelt sympathy and pray to God, to comfort and console them that they may bear their trials with fortitude. Be it further

RESOLVED, that a copy of these resolutions be sent to his family and spread upon the minutes of the meeting.

J. J. DAVEY, Chairman
H. J. SCHOLLS
THOMAS BURDETT.

MEMBERSHIP LIST

IMPORTANT NOTICE TO MEMBERS

Those whose names do not appear in this list will understand that they are in arrears for dues to and including 1921, and are suspended from membership until the amount due is paid as provided by the penalty clause of the Constitution and By-Laws, official notice having been mailed to their last known address.

If your name is wrongly spelled or the address given is not correct, please notify the Secretary at once that errors may be corrected in Index Card system which has been installed in place of a book record. Also kindly give immediate notice of any future change in your title, business connection or post office address.

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